

State Space Modelling of Contest and Co-Regulation in Dog-Guardian Dyads

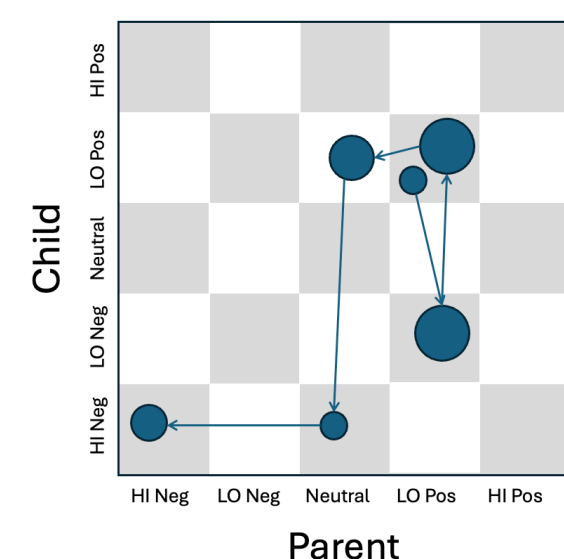
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Background and Aims

Dog-human relationships are among the most widespread cross-species bonds, with significant implications for dog welfare and training, human well-being and safety, and everyday cohabitation.^{1,2} Yet, research on dog-human interaction has traditionally examined dog and human behaviour separately.³ In this study, we adopted a dyadic framework, treating the dog-guardian pair as the unit of analysis.

State Space Grids (SSGs) are a methodological tool that allow researchers to visualize dynamic interactions from moment to moment.^{4,5} SSGs are frequently used to analyze synchronized event sequences in human interactions in developmental psychology research (e.g., how significant events, such as a conflict between parent and child, influence affective states).



Redrawn from Hollenstein (2007) SSG depicting 15s of a parent-child interaction. The size of the circles denotes the event duration.

The present study is the first to use State Space Grids to analyze dog-human interactions. Specifically, we used SSGs to assess how high conflict during a challenging food task influences the subsequent behavioural patterns of dog-guardian dyads during a free play period after the task (Free Play 2). To do so, behaviour in the free play period was compared to behaviour in a free play period that preceded the challenging food task (Free Play 1).

- 1. Are guardians more directive and controlling after a high-conflict event?**
Is more time spent in a directive/controlling state in Free Play 2 compared to Free Play 1?
- 2. Are dogs more distressed and aroused after a high-conflict event?**
Is more time spent in a distressed/aroused state in Free Play 2 compared to Free Play 1?
- 3. Is the dog-guardian interaction more negative after a high-conflict event?**
Does the dyad spend more time in a negative interaction state in Free Play 2 compared to Free Play 1?

Behavioural Coding

Free Play Sessions: Each 5-minute session was divided into ten second intervals; the most predominant behaviour was coded.

Guardian	Dog
1 = Inattentive	1 = Inattentive/Withdrawn
2 = Passive/Observing	2 = Monitoring/Oriented
3 = Supportive/Encouraging	3 = Engaged/Positive
4 = Directive/Controlling	4 = Distressed/Negative

(N = 109) (N = 109)

Surprise (Challenging) Food Task: The highest level of conflict observed was coded.

Code & Label	Definition	
0 = No Interest	Dog ignores the food. Guardian does nothing.	Low Conflict (n = 31 dyads)
1 = Permissive/Passive	Dog shows interest/eats; guardian doesn't intervene.	
2 = Intervention	Guardian uses verbal/gestural cues, dog may respond.	High Conflict (n = 78 dyads)
3 = High Arousal	Guardian intervenes and dog displays visible arousal.	
4 = Physical Intervention/Restraint	Guardian physically stops dog, and both show high arousal or tension.	

Analyses were restricted to high-conflict dyads (n = 78)

Procedure

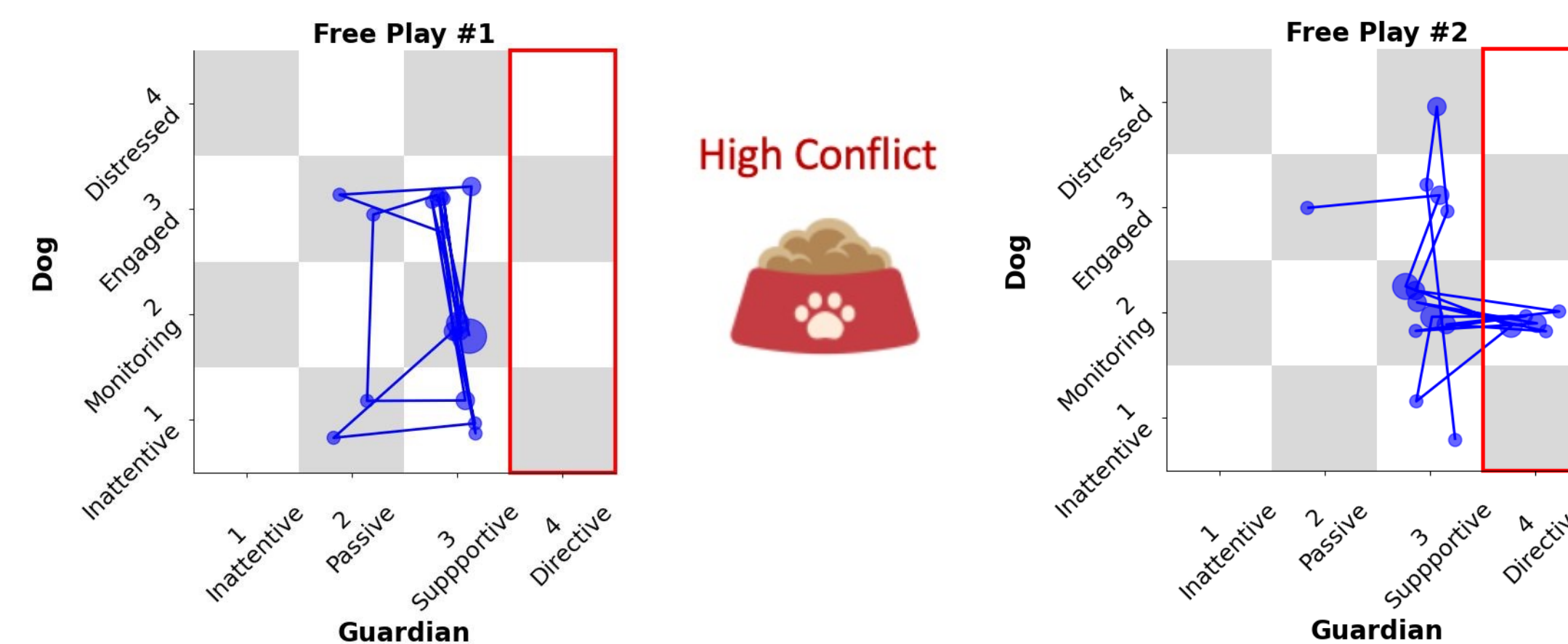


Results

1. Are guardians more directive and controlling after a high-conflict event?

Guardians spent a greater proportion of time in a directive/controlling state in Free Play 2 ($M = 0.04$, $SD = 0.01$) compared to Free Play 1 ($M = 0.02$, $SD = 0.009$), ($t(77) = -2.19$, $p = .031$).

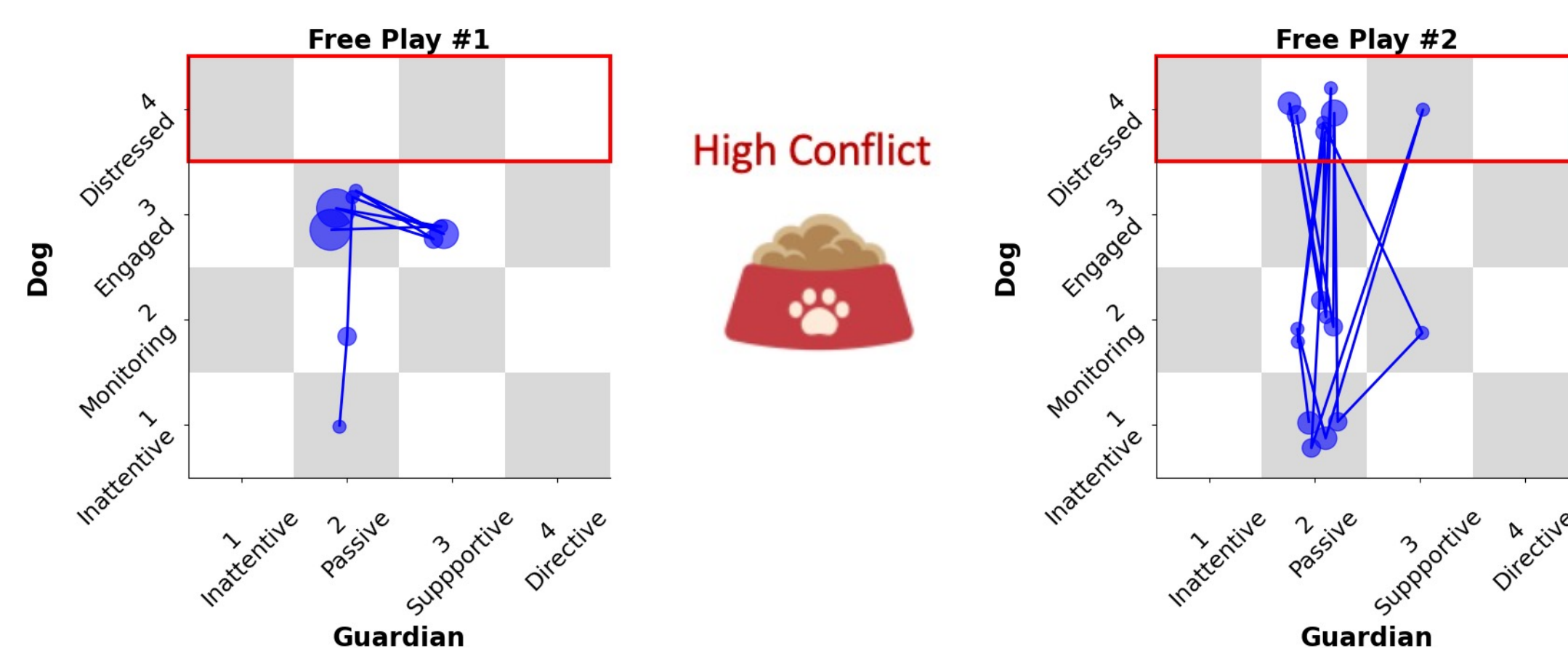
Figure depicts an example dyad.



2. Are dogs more distressed and aroused after a high-conflict event?

Dogs spent a greater proportion of time in a distressed/high arousal state in Free Play 2 ($M = 0.09$, $SD = 0.14$) compared to Free Play 1 ($M = 0.04$, $SD = 0.12$), ($t(77) = -3.29$, $p = .002$).

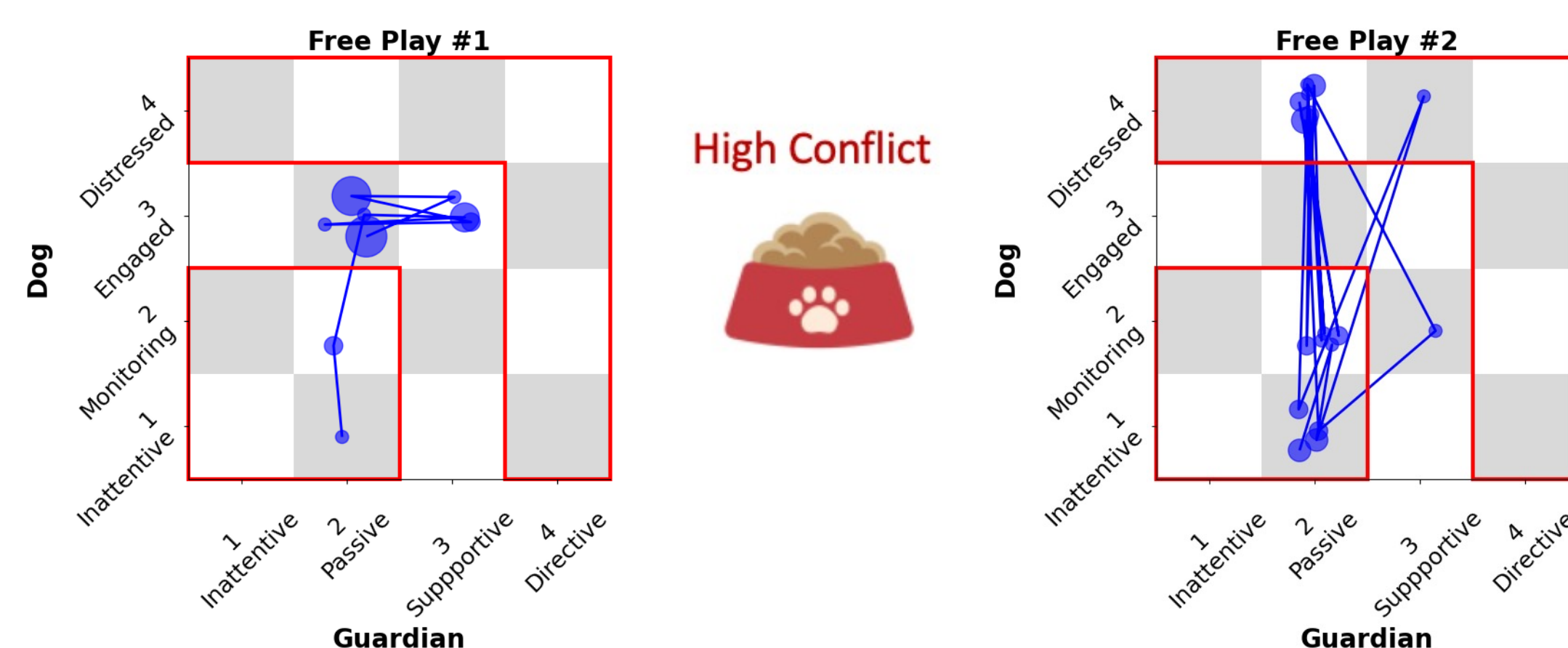
Figure depicts an example dyad.



3. Is the dog-guardian interaction more negative after a high-conflict event?

Dyads spent more time in cells representing negative interaction states in Free Play 2 ($M = 0.24$, $SD = 0.14$) compared to Free Play 1 ($M = 0.12$, $SD = 0.16$), ($t(77) = -5.92$, $p = <.001$).

Figure depicts an example dyad.



Note: Red = negative interaction region.

Discussion

1. Guardians were more directive and controlling after a high-conflict event. Following a conflict with their dog, where their dog may have acted in undesirable ways, guardians may have felt pressure to be more controlling because they were worried about being judged by others. This is consistent with research suggesting that one of the main challenges guardians face when their dog behaves poorly in public settings is the feeling of judgment from others and the pressure to manage their dog's behaviours.⁶

2. Dogs were more distressed and aroused after a high-conflict event. After experiencing conflict with their guardian, in which their guardian was raising their voice or physically stopping them from accessing the food, it is possible that the dogs were adopting negative emotional states, causing them to experience similar signs of distress. Previous research suggests that because of their unique relationship with humans, dogs experience a form of emotional contagion with their guardians, automatically adopting and mirroring guardians' emotional states.⁷

3. The dog-guardian interaction was more negative after a high-conflict event. Dyads spent less time in a positive interaction state (i.e., engaged and supportive) after a high-conflict event. It is possible that the dogs were using appeasement behaviours (e.g., avoiding eye gaze with their guardian, crouching, or lying down) after the conflict,⁸ leading to the dog's physical disengagement with the environment and guardian. Though guardians were at times supportive of engagement post-conflict, they were less so than prior to the conflict.

The use of State Space Grids for studying dog-human interactions
We found that SSGs can support the study of dog-human interactions by providing a visualization of the dynamic interactions that, in turn, supports theory-driven hypothesis testing. The current study provided a 'proof of concept', though future studies can do much more; for example, studies may consider the time-course of the interaction (e.g., does guardians' directive behaviour precede or follow negative behaviour from dogs?).

References

- Gee, N. R. et al. (2021). Dogs Supporting Human Health and Well-Being: A Biopsychosocial Approach. *Frontiers in Veterinary Science*, 8, 630465.
- González-Ramírez M. T. (2019). Compatibility between humans and their dogs: Benefits for both. *Animals*, 9(9), 674. Used
- Samet, L. E. et al. (2022). Exploring and Developing the Questions to Measure the Human-Dog Bond: New and Existing Themes. *Animals*, 12(7), 805.
- Hollenstein, T. (2007). State Space Grids: Analyzing dynamics across development.
- Granic, I., & Lamey, A. V. (2002). Combining dynamic systems and multivariate analyses to compare the mother-child interactions of externalizing subtypes. *Journal of Abnormal Child Psychology*, 30(3), 265-283.
- Hart, C. J., & King, T. (2024). "It's Okay He's Friendly": Understanding the experience of owning and walking a reactive dog using a qualitative online survey. *Anthrozoös*, 37(2), 379-400.
- Rial, L. A. et al. (2025). Affiliative and stress behaviors of domestic dogs when they witness a human conflict between their caregivers. *Applied Animal Behaviour Science*, 289.
- Cavalli, C. et al. (2016). Post-Conflict affiliative behaviors towards humans in domestic dogs (*Canis familiaris*). *International Journal of Comparative Psychology*, 29.

Acknowledgements

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